

## THE SUMMER DIET OF THE YELLOW RAIL IN SOUTHERN QUÉBEC

MICHEL ROBERT,<sup>1</sup> LOUISE CLOUTIER,<sup>2</sup> AND PIERRE LAPORTE<sup>1</sup>

ABSTRACT.—We documented Yellow Rail (*Coturnicops noveboracensis*) food habits through the use of tartar emetic, a non-destructive method to collect stomach contents. A total of 71 rails were forced to regurgitate during 9 Jun.–25 Aug. 1994 and 16 May–31 Jul. 1995, from which we obtained 105 emetic samples. Almost 95% (99/105) of samples contained food items. Overall, mean number of taxa within one sample was 4.7 (SD = 3.2; Range = 1–13; N = 99): 1.1 (SD = 1.6; Range = 0–7) for seeds and 3.6 (SD = 2.1; Range = 0–8) for invertebrates. Sand grit, feather fragments, and plant fragments were also identified in many samples. Totals of 1169 organisms from 52 taxa were identified and counted in the samples: 372 seeds from 18 taxa and 797 invertebrates from 34 taxa. Invertebrates and seeds had relative frequencies of 68.1% and 31.9%, respectively, and the mean number of individuals counted within samples was significantly higher ( $P < 0.001$ ) for invertebrates (Mean = 8.1; SE = 0.8; Range = 0–44) than for seeds (Mean = 3.8; SE = 0.9; Range = 0–44). Among the first group, Coleoptera (beetles) were by far the most important food, representing almost two-thirds of invertebrates eaten and having a relative frequency of 42.5%. Araneae (spiders) were second, with a relative frequency of 13.3%, while other taxa ranked far lower. Of seeds identified, Cyperaceae (sedges) and Juncaceae (rushes), particularly genera such as *Carex*, *Juncus*, and *Eleocharis*, were the most important food items, with relative frequencies of 12.7%, 6.5%, and 3.1%, respectively. According to our results, during summer the Yellow Rail is mostly an arthropod-feeder that complements its diet with seeds. Effects of tartar emetic on birds were negligible and this technique appeared to be very successful, suggesting that it could be used as an alternative to sacrificing rails in future dietary studies. Received 30 Oct. 1996, accepted May 1997.

The Yellow Rail (*Coturnicops noveboracensis*) is one of North America's least studied birds (Bookhout 1995, Robert 1997). Many reports state that snails are the principal food taken by this bird (Peabody in Bent 1926, Walkinshaw 1939, Stalheim 1974:8, Ripley 1977, Bookhout 1995). Only Martin et al. (1951), Easterla (1962), Stalheim (1974), and Martin and Perry (1981) published quantitative information on the diet of wild-caught Yellow Rails, and their results refer to only 20 or so individuals, many of which were collected during migration or in winter. Moreover, a portion of their gizzard contents was not consistently preserved in alcohol, which brings into question the reliability of some results (Stalheim 1974). Other publications dealing with the food habits of Yellow Rails either refer to captive birds (Devitt 1939, Stalheim 1975) or are too gen-

<sup>1</sup> Canadian Wildlife Service, Québec Region, Environment Canada, 1141 route de l'Église, C. P. 10100, Sainte-Foy, Québec, Canada G1V 4H5.

<sup>2</sup> Univ. de Montréal, Collection Ouellet-Robert, Dépt. de sciences biologiques, C. P. 6128, succursale Centre-Ville, Montréal, Québec, Canada H3C 3J7.

eral or anecdotal to present a clear picture of the bird's diet (Wayne 1905, Walkinshaw 1939, Huber 1960).

In Québec, as in some other parts of North America (Bookhout 1995), the Yellow Rail is considered to be a vulnerable species because of its rarity and the fragility of its habitat (Robert 1996). As part of our ongoing investigations of threatened birds in Québec, we captured and banded Yellow Rails (Robert and Laporte 1997) and subsequently took advantage of this opportunity to document food habits of this species using tartar emetic, a non-destructive method to collect stomach contents. In this paper, we present and discuss quantitative analysis of foods taken by Yellow Rails during summer. We also present fresh weights of the rails caught and discuss their weight variations in relation to tartar emetic use.

#### STUDY AREA AND METHODS

In 1994 and 1995, we banded Yellow Rails in marshes along the St. Lawrence River. From southwest to northeast along the St. Lawrence corridor, we worked in the Lac Saint-François (45°02'N, 74°32'W) and Cap Tourmente (47°03'N, 70°49' W) National Wildlife Areas (NWA), at Île aux Grues (47°04'N, 70°33'W), Cacouna (47°56'N, 69°31'W), and at Gaspé Bay (48°50'N, 64°29'W). The salinity of the St. Lawrence River varies depending on location: the water is fresh in Lac Saint-François, brackish at Cap Tourmente and Île aux Grues, and salty at the other sites. The vegetation of these marshes is low herbaceous graminoids (<1 m high), chiefly sedges (Cyperaceae), rushes (Juncaceae) and true grasses (Gramineae) (Robert and Laporte 1996).

All rails were caught at night (22:30–03:30, DST) from mid-May to late August, with techniques described in Robert and Laporte (1997). Rails were weighed to the nearest gram using a 100-g Pesola scale and sexed according to bill color; during the breeding season, males have a yellowish bill and females a much darker one (Walkinshaw 1939, Stalheim 1974). They were forced to regurgitate by orally administering to them a 1.5% solution of antimony potassium tartrate (tartar emetic) according to the method of Poulin et al. (1994), but at a dosage increased from 0.8 cm<sup>3</sup> to 0.9 cm<sup>3</sup> per 100 g of body mass. We used a small, 6-cm feeding tube (gauge 8 FR) attached to a 1-cm<sup>3</sup> syringe to inject the solution. The emetic was administered slowly, over a two minute period, waiting for the bird to swallow and recover whenever necessary. Once the emetic was given, the rail was placed in a small dark box lined with white cotton fabric and was released 15–20 min later after having regurgitated and recovered. All food items were then immediately transferred to glycerinated 70% ethanol.

All items found in samples were identified in the laboratory by one person (LC), using a dissecting microscope. They were first classified into sand grit, feathers, plants, Gastropoda, seeds, or Arthropoda. For each sample, grains of sand and feather rachis fragments were individually counted, while plants, which were too much fragmented to be identified, were quantified using a semi-quantitative relative abundance scale: 0 (no plant), 1 (small quantity), 2 (medium quantity), and 3 (large quantity). For each sample, Gastropoda were individually counted using shell apex, while seeds and Arthropoda were specifically counted and identified using reference collections of species found in studied habitats. Nearly all Arthropoda were highly digested and fragmented, and their identification was based on the most characteristic and least digestible parts of their body. They were classified and counted,

using chelicerae for Araneae, metasomatic segments for Hymenoptera, elytra base for Coleoptera, and head parts or wings for other taxa.

We calculated the overall mean number of food types counted in gizzard contents for samples containing food, as well as the frequency of occurrence for all food types within samples. We also calculated the relative frequency for all seeds and invertebrates i.e., the number of individuals in each taxon as a proportion of the total individuals in all taxa, expressed in percentage. Using Kruskal-Wallis tests, we tested differences in mean numbers of seeds and invertebrates in samples collected at Île aux Grues, Lac Saint-François NWA, and Cacouna. We also tested, from data collected at Île aux Grues, for the significance of a possible association between sample collection dates and number of predominant food types using Kendall's coefficient of rank correlation. We used a Wilcoxon test to compare the number of seeds and the number of invertebrates counted within samples, as well as a paired *t*-test to compare the mean weight of rails before and after the treatment with the emetic solution.

## RESULTS

A total of 71 Yellow Rails were forced to regurgitate during 9 Jun–25 Aug. 1994 and 16 May–31 Jul. 1995, from which we obtained 105 samples. Almost 95% of samples (99/105) contained recognizable food items, while six were strictly liquid. Most rails regurgitated once ( $N = 46$ ), but some were recaptured and forced to regurgitate a second ( $N = 18$ ), third ( $N = 5$ ), and fourth ( $N = 2$ ) time during a given year. More than three-quarters of samples (76/99) containing recognizable food were obtained at Île aux Grues, 10 at Lac Saint-François NWA, nine at Cacouna, three in Gaspé Bay, and one at Cap Tourmente NWA. Up to and including the time of release, neither mortality nor discernable weakness was observed in the captured rails; many birds (26/71) were recaptured after having been treated with the emetic.

Overall, the mean number of taxa identified within one sample was 4.7 ( $SD = 3.2$ ; range = 1-13;  $N = 99$ ): 1.1 ( $SD = 1.6$ ; range = 0-7) for seeds and 3.6 ( $SD = 2.1$ ; range = 0-8) for invertebrates. Moreover, sand grit, feather fragments, and plant fragments were identified in many samples. Feather and plant fragments (mostly dead vegetation) were present in most samples but usually not in large quantities (Table 1). Overall, a total of 1169 organisms from 52 taxa were identified and counted in all samples; 372 seeds from 18 taxa and 797 invertebrates from 34 taxa. Among seeds, Cyperaceae (*Carex hornatodes*, *C. paleacea*, *C. echinata*, *Carex* sp., and *Eleocharis* sp.) and Juncaceae (*Juncus balticus*) were the most represented families, with 49.5% and 20.4% of all seeds counted, respectively. These, along with Graminaeae (*Spartina pectinata* and/or *Calamagrostis canadensis* and/or *Festuca rubra*) and Lythraceae (*Lythrum salicaria*) had the highest frequencies of occurrence (Table 1) and were also either dominant or co-dominant in the marshes studied (Robert and Laporte 1996). Except for at least eight taxa that could not be iden-

TABLE 1  
SUMMER FOOD TYPES FOUND IN EMETIC SAMPLES (N = 99) OF YELLOW RAILS FROM  
SOUTHERN QUÉBEC

	Number of taxa identified (minimum)	Number of indiv. counted	Mean number indiv./ sample	Maximum number indiv./ sample	Frequency of occurrence	Relative frequency
<b>Seeds</b>	<b>18</b>	<b>372</b>	<b>7.8</b>	<b>44</b>	<b>48.5</b>	<b>31.9</b>
Polygonaceae	1	7	3.5	6	2.0	0.6
Lythraceae	1	13	1.6	5	8.1	1.1
Rubiaceae	1	10	1.7	5	6.1	0.9
Juncaginaceae	1	2	1.0	1	2.0	0.2
Juncaceae	1	76	7.6	24	10.1	6.5
Cyperaceae	4	184	5.6	38	33.3	15.7
Gramineae	1	22	2.0	6	11.1	1.9
Unidentified	8	58	2.8	26	21.2	5.0
<b>Invertebrates</b>	<b>34</b>	<b>797</b>	<b>9.1</b>	<b>44</b>	<b>90.9</b>	<b>68.1</b>
Gastropoda	1	55	1.5	6	37.4	4.7
Hirudinea	1	2	2.0	2	1.0	0.2
Acarina	1	4	1.0	1	4.0	0.3
Araneae	1	156	2.7	10	57.6	13.3
Collembola	1	7	1.2	2	6.1	0.6
Psocoptera	1	6	2.0	3	3.0	0.5
Mallophaga	1	1	1.0	1	1.0	0.1
Hemiptera	1	1	1.0	1	1.0	0.1
Homoptera	1	5	1.0	1	5.1	0.4
Thysanoptera	1	1	1.0	1	1.0	0.1
Coleoptera	14	497	7.0	41	71.7	42.5
Trichoptera	1	1	1.0	1	1.0	0.1
Hymenoptera	1	4	2.0	3	2.0	0.3
Diptera	7	53	2.2	10	24.2	4.5
Diptera pupae	1	2	1.0	1	2.0	0.2
<b>Others</b>	—	—	—	—	<b>79.8</b>	—
Sand grit	—	33	2.8	19	12.1	—
Feather fragments	—	297	5.1	23	58.6	—
Plant fragments	—	—	— <sup>a</sup>	—	67.7	—

<sup>a</sup> Frequency distribution of semi-quantitative classes: 0 = 32.3%, 1 = 25.3%, 2 = 30.3%, 3 = 12.1%.

tified, the remaining seeds found in the samples were from Polygonaceae (*Polygonum* sp.), Rubiaceae (*Galium* sp.), and Juncaginaceae (*Triglochin maritima*) families.

Among invertebrates, the most common food items were Coleoptera, Araneae, Gastropoda, and Diptera, with 62.4%, 19.6%, 6.9% and 6.6% of all animals counted, respectively (Table 1). Many Coleoptera and Diptera families were identified. They were, in decreasing importance: Hy-



drophilidae (*Helophorus* sp. and *Cymbiodyta vindicata*), Curculionidae (*Listronotus* sp. and  $\geq 2$  unidentified spp.), Carabidae (*Poecilus* and/or *Pterostichus* and/or *Harpalus* and/or *Patrobus* genera), and Sylphidae (*Thanatophilus lapponicus*) for Coleoptera, and Chironomidae ( $\geq 1$  sp.), Ceratopogonidae ( $\geq 1$  sp.), Culicidae ( $\geq 1$  sp.), Dolichopodidae ( $\geq 1$  sp.), Tipulidae (*Dicranota* sp.), and Simuliidae ( $\geq 1$  sp.) for Diptera. At least eight more taxa, seven Coleoptera and one Diptera that could not be identified, were found in the samples. Other invertebrates identified, in decreasing relative frequencies and frequencies of occurrence, were insects from Collembola ( $\geq 1$  sp.), Homoptera ( $\geq 1$  sp.), Psocoptera ( $\geq 1$  sp.), Hymenoptera ( $\geq 1$  Formicidae), Mallophaga ( $\geq 1$  sp.), Hemiptera ( $\geq 1$  Corixidae), Thysanoptera ( $\geq 1$  sp.), and Trichoptera ( $\geq 1$  sp.) orders, as well as Acarina ( $\geq 1$  sp.) and Hirudinea ( $\geq 1$  sp.) (Table 1).

Overall, invertebrates and seeds had relative frequencies of 68.1% and 31.9% respectively, while the overall mean number of individuals counted within samples was significantly higher (Wilcoxon test,  $\chi^2 = 40.8$ ,  $P < 0.001$ ) for invertebrates (Mean = 8.1; SE = 0.8; range = 0–44; N = 99) than for seeds (Mean = 3.8; SE = 0.9; range = 0–44; N = 99). Among the first group, Coleoptera was by far the most important food taxon, representing almost two-thirds of invertebrates eaten and having a relative frequency of 42.5%. Hydrophilidae and Curculionidae had particularly high relative frequencies among Coleoptera: 19.3% and 13.4% respectively. The taxon Araneae was second among invertebrates, with a relative frequency of 13.3%, while other taxa followed far behind. Among the latter taxa, Diptera and Gastropoda had relative frequencies less than 5.0% (Table 1). Cyperaceae and Juncaceae, particularly the genera *Carex*, *Juncus*, and *Eleocharis*, were the most important food items among seeds with relative frequencies of 12.7%, 6.5% and 3.1%, respectively.

We did not find any significant differences (Kruskal-Wallis test,  $P > 0.05$ ) between mean numbers of seeds and invertebrates counted in samples collected at Île aux Grues, Lac Saint-François NWA and Cacouna. We did not find significant correlations (Kendall statistics,  $P > 0.05$ ) between collection dates and numbers of seeds, invertebrates, Coleoptera or Cyperaceae counted in samples collected at Île aux Grues, although there was a significant negative relationship between the numbers of Araneae found in samples and collection dates (Kendall's Tau =  $-0.18$ ,  $P = 0.04$ ).

All rails had a predominantly yellow bill and were considered as males. Their mean weight was 60.9 g (N = 71; SD = 3.5; range = 53–70 g). The mean weight of birds forced to regurgitate did not vary significantly before they were treated with tartar emetic and after they were recaptured (two-sided paired  $t$ -test,  $P = 0.52$ , N = 36).

## DISCUSSION

This study represents the first exhaustive report of summer food habits of Yellow Rails. Our results indicate that this species feeds on a wide variety of resources, including both animal and vegetal matter in its diet. This reflects an opportunistic foraging strategy which contrasts with statements closely associating Yellow Rails and snails. Not only was the number of food taxa found in our samples generally high, but also the relative importance of snails in our samples appeared to be fairly low (although snails were numerous in all studied habitats). According to our data, the Yellow Rail, during summer, is predominantly an arthropod-feeder that complements its diet with seeds. This is in agreement with Stalheim's (1974) statement that although seeds may at times comprise a large part of its diet, invertebrates appear to be a regular and important feature. He also noted that the Yellow Rail's gizzard is anatomically more similar to that of the Virginia Rail (*Rallus limicola*) than to that of the Sora (*Porzana carolina*), and because Virginia Rails consume a much higher percentage of animal foods than do sympatric Soras (Horak 1970, Conway 1995), he suggested that Yellow Rails may be more adapted to a diet of invertebrates than to a diet of seeds. The low incidence of sand grit in our samples corroborates Stalheim's (1974) suggestion; the quantities found in this study are similar to those measured in the invertebrate-eating Virginia Rails, which are much lower than those measured in seed-eating birds such as Soras (Horak 1970).

No published information had clearly shown the relative importance of animal matter in the diet of the Yellow Rail. Many invertebrate taxa were identified by Martin et al. (1951), Easterla (1962), and Stalheim (1974), but the minute quantities found in the gizzards they analysed did not permit numerical estimations. However, traces of Gastropoda, Pelecypoda, Arachnida, Crustacea, Orthoptera, Hemiptera, Coleoptera, Diptera, and Hymenoptera were identified in their samples. Other information on invertebrates being eaten by Yellow Rails is extremely rare: Diplopoda (millipedes) made up 23% of the gizzard volume for one bird collected in Missouri (see Stalheim 1974), Tettigonidae (grasshoppers) and Amnicolidae (snails) made up 40% and 25%, respectively, of the gizzard volume for one rail shot in Maryland (Martin and Perry 1981), while snails made up 90% of the gizzard volume for one bird collected in Massachusetts (Martin and Perry 1981). Seeds made up a major part of the gizzard contents of Yellow Rails collected to date and a few plant taxa were identified, including *Acalypha virginica*, *Ambrosia* sp., *Carex* sp., *Eleocharis* sp., *Myrica* sp., *Polygonum* sp., *Rosa* sp., *Scirpus acutus*, *Scleria* sp., *Setaria glauca*, and *Viola sagittata* (Stalheim 1974, Martin and Perry

1981). Although we can infer that seeds may sometimes make up a large part of the diet of individual birds, even in summer (Easterla 1962, Stalheim 1974, this study), it is likely that the relative importance of seeds was overestimated in most of previous studies because the gizzards were not preserved soon after bird's deaths and seeds take longer to digest than soft-bodied arthropods (Stalheim 1974). Moreover, most of previous studies samples were taken from Yellow Rails collected during migration or during winter, when a bird's diet may differ considerably from its summer food. For instance, Martin et al. (1951) showed that Virginia Rails do consume seeds more commonly in fall (32%), winter (21%), and spring (12%) than in summer (3%), which could also be the case for Yellow Rails (see also Meanley 1992).

Many of the animal and plant taxa found in our samples had never been reported in the Yellow Rail diet studies. These include Hirudinea (leeches) and two individuals were actually found in the gizzard contents of one rail caught at Île aux Grues. It seems that leeches are rarely preyed upon by rallids (see Bent 1926, Martin et al. 1951, Ohmart and Tomlinson 1977, Cramp 1980), which our results tend to corroborate. In our view, it is likely that leeches are taken by Yellow Rails mainly because they sometimes are parasitized by these annellids: during our study, four of the Yellow Rails we caught had a leech attached to its toe or tarsus. Other food taxa reported for the first time within this study are seeds from Lythraceae, Rubiaceae, and Juncaginaceae families and invertebrates from Acarina, Collembola, Psocoptera, Mallophaga, Homoptera, Thysanoptera, and Trichoptera orders.

Although nearly all samples contained food items and although the overall mean number of food types found within one sample was fairly high, most samples were made up of only a few highly digested items. This suggests that the gizzard of many rails was mainly empty when we forced them to regurgitate, which could be due to the fact that the birds were always caught at night (Robert and Laporte 1997). Stalheim (1974), who studied semi-captive Yellow Rails, did not observe feeding during night-time in spite of regular night observation, but observed birds feeding from sunrise to nearly sunset. Telemetric studies (Bookhout and Stenzel 1987, Robert and Laporte 1996) also showed that Yellow Rails are sedentary at night and mobile during the day. In our view, the small quantities of food found in our samples corroborate Stalheim's observation, i.e., that the Yellow Rail is a daytime feeder. Thus, it is likely that our results underestimate prey items with higher digestability such as small soft-bodied arthropods, eggs, insect larvae, and worms (see Swanson and Bartonek 1970). Inversely, our results probably slightly overestimate the relative importance of hard-bodied food items, particularly



seeds, and probably beetles and snails also. Although quite exceptional, it is worth reporting that we once observed a Yellow Rail capturing and eating two mosquitoes (Diptera, Culicidae) after it was released from banding i.e., during the night.

There are no previous reports on emetics being used with rallids (Poulin et al. 1994, Poulin and Lefebvre 1995). According to our experience, tartar emetic was a successful technique for the investigation of food preference in Yellow Rails; only 5.7% of the birds failed to regurgitate food items and several invertebrate and plant taxa were found in our samples. Furthermore, rails that were manipulated showed no sign of illness when released, and no significant differences were found between pre-treatment and post-treatment weights, suggesting that post-release effects of tartar emetic were negligible, if not non-existent (see also Poulin and Lefebvre 1995). Before beginning our study on Yellow Rails, we also tested tartar emetic with Virginia Rails on three occasions, and always had positive results. In our view, this technique could be used as an alternative to sacrificing rallids in future dietary studies, particularly for those taxa considered rare, endangered or threatened (see Eddleman et al. 1988).

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